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(71) Applicant *(for all designated States except US)*: BASS PLC [GB/GB]; 137 High Street, Burton-on-Trent, Staffordshire DE14 1JZ (GB).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: BAXTER, William, Ronald, Stuart [GB/GB]; 122 Chesterton Road, Cambridge CB4 1BZ (GB). BIDDLE, Howard, William [GB/GB]; 7 Park Lane, Histon, Cambridge CB4 4JJ (GB). PAINE, Lisa, Jane [GB/GB]; 91 Dovedale Avenue, Long Eaton, Nottingham NG10 3HT (GB). MOLZAHN, Stuart, William [GB/GB]; Stagsfell House, Osmaston, Ashbourne, Derbyshire DE1 1LW (GB).

(74) Agents: PEARCE, Anthony, Richmond et al.; Marks & Clerk, Alpha Tower, Suffolk Street Queensway, Birmingham B1 1TT (GB).

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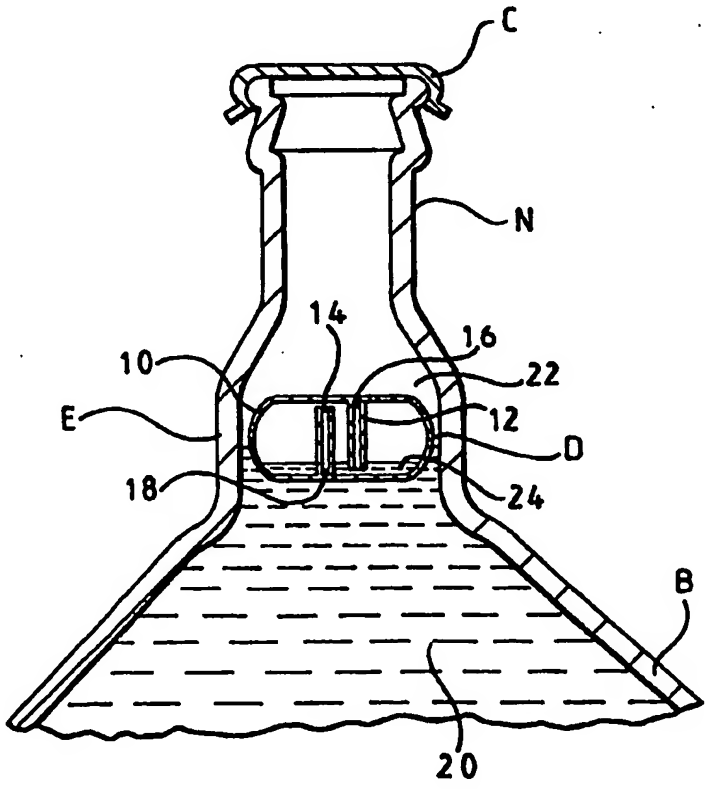
(57) Abstract

A sealed, openable, pressurised liquid container comprises a bottle B partly filled with liquid to provide a headspace (22). A foam-promoting device D floats on the liquid in the bottle. The device D comprises a hollow body (10) having first and second tubes (12 and 14). The first tube (12) has an upper end in communication with the exterior of the hollow body via a restricted orifice (16) disposed in the headspace (22) in the bottle, and a lower end in communication with the interior of the hollow body (10). The second tube (14) has a lower end in communication with the exterior of the hollow body via a restricted orifice (18) disposed below the surface of the liquid (20) in the bottle B, and an upper end in communication with the interior of the hollow body (10). The lower end of the first tube (12) is disposed at a lower level than the upper end of the second tube (14). The device D is partly filled with liquid (24) to a level intermediate the levels of the lower end of the first tube (12) and the upper end of the second tube (14) so that the lower end of the first tube (12) is submerged in the liquid (24) in the device D and the upper end of the second tube (14) is disposed above the level of the liquid (24) in the device D.



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CONTAINER FOR PRESSURIZED LIQUIDS WITH FOAM GENERATING DEVICE

This invention relates to sealed, openable, pressurised liquid containers, to foam-promoting devices for use in such containers and to a method of manufacture thereof, and is more particularly, but not exclusively, concerned with beverage containers such as bottles.

Such containers when used for beverages such as beer and lager, have enjoyed considerable commercial success and have employed a wide variety of designs of insert. In the manufacture of such containers when in the form of cans, the insert is introduced into the can through the open top thereof and secured in position towards the bottom of the can. The can is then partially filled with carbonated beverage and then sealed and pressurised. Sealing is effected by means of a can top having an opening closed by a pull-tab. Pressurisation is commonly effected by dosing the can with a small quantity of liquid nitrogen immediately before sealing it so that the nitrogen boils and increases the pressure within the sealed container. The sealed and pressurised can is then heated, usually in an inverted state, to pasteurise the contents and then cooled to ambient temperature.

In use, the consumer opens the can using the pull tab. The act of opening the pull tab causes the internal pressure within the can to be released suddenly and this causes gas to be ejected from the foam-promoting device through a restricted orifice in the foam-promoting device and into the beverage to promote the formation of foam within the beverage.

WO91/07326 describes a number of different designs of foam-promoting device, all of which are pre-filled with gas under pressure before being inserted into the container and which include a relief valve serving to maintain the foam-promoting device in a sealed state until the container is opened by the consumer. The foam-promoting device is designed so that the pressure difference at which the valve opens is reduced during pasteurisation so as to enable the valve to open when the container is opened by the consumer. Foam-promoting devices of this type, being highly pressurised foam-promoting devices which are sealed until the container is open, have the disadvantage that the foam-promoting device may still be highly pressurised after the container has been opened and the contents dispensed. This can be a potential risk to a consumer who opens the empty container and interferes with the pressurised foam-promoting device.

This disadvantage is not possessed by various other known types of foam-promoting device having a restricted orifice which provides permanent communication between the interior of the foam-promoting device and the main body of beverage within the container. Many designs of foam-promoting device operating on this principle are known and have enjoyed considerable commercial success. For example, foam-promoting devices operating on this principle have been disclosed in GB-A-1266351, GB-A-2183592, GB-A-2257132 and WO94/14678. Such foam-promoting devices where the restricted orifice is permanently open have to be designed so that the loss of gas from the foam-promoting device is minimised before the container is eventually opened by the consumer. As a result, it is rather difficult to ensure that the foam-promoting device is initially filled with the appropriate gas, usually nitrogen. It is necessary to exclude oxygen from the interior of such

foam-promoting devices because the presence of oxygen can lead to undesirable spoilage of the beverage. In GB-A-2257132 and WO94/14678, foam-promoting devices are described which rely on minimising the amount of beverage which enters the foam-promoting device by promptly inverting the container after filling and sealing so that the restricted orifice is in the headspace in the inverted container. Such a procedure ensures that, as the pressure in the container rises following sealing of the container and reaches a maximum during pasteurisation, the restricted orifice in the foam-promoting device is always in communication with the headspace in the container.

Foam-promoting device designs which are easier to flush with gas are disclosed in WO95/08493 where upper and lower restricted orifices are provided to assist in flushing. Such foam-promoting devices operate without an unacceptable loss of gas because the foam-promoting device contains a small amount of beverage which causes the lower restricted orifice to be submerged in beverage whilst the upper restricted orifice is exposed to the headspace within the foam-promoting device. The upper restricted orifice is of a size such that the bubble point effect prevents loss of gas from the foam-promoting device because pressure equalisation internally and externally of the foam-promoting device within the sealed container can occur by passage of beverage in the appropriate direction through the lower orifice. When the container is opened, the resultant large and virtually instantaneous pressure drop which thereby occurs overcomes the bubble point effect and causes discharge of gas through the upper restricted orifice into the beverage to promote foam formation.

Many of the above-described foam-promoting devices having restricted orifices which are permanently open rely on the container being promptly inverted after filling and sealing and remaining inverted during pasteurisation and subsequent cooling. However, with certain types of container, notably bottles, it is not usual or practicable to invert them for pasteurisation. Indeed, in the case of bottles, damage can occur if it is attempted to invert them on a high speed bottling line.

Whilst most of the above described beverage containers which are currently on the market are of the type in which the foam-promoting device is fixed at or near the bottom of the container, foam-promoting devices of the floating type are becoming attractive for containers such as bottles in which it is difficult and inconvenient to secure the foam-promoting device in position at or near the bottom of the container.

Of the foam-promoting devices disclosed in WO91/07326, most of these are arranged to be secured within the container so as to be completely submerged in the liquid. However, there is also described a foam-promoting device which floats freely within the container and which is weighted so as to keep the restricted orifice submerged. GB-A-2183592 also discloses the possibility of utilising a foam-promoting device which floats and which is weighted to discharge the contents of the foam-promoting device downwardly into the beverage upon opening of the container.

GB-A-2279056 (and corresponding WO95/00415) and GB-A-2279057 (and corresponding WO95/00416) also disclose foam-promoting devices of the floating type. Such foam-promoting devices are pre-filled with

pressurised gas and have a closure for preventing release of pressurised gas through the restricted orifice in the foam-promoting device. With such a design, the closure is arranged to be permanently and irreversibly opened on being subjected to a temperature above a predetermined threshold or being subjected to a pressure difference in which the pressure in the container exceeds that within the foam-promoting device. Such closure is intended to be permanently and irreversibly opened during the subsequent pasteurisation step. However, these foam-promoting devices are relatively expensive because of the need to provide the closure and also rely on successful permanent and irreversible opening of the closure to be effective and safe for the consumer.

GB-A-2280886 (and corresponding WO95/05326) discloses a number of floating foam-promoting devices having upper and lower opening means, wherein one of the opening means is an orifice and the other opening means is a one-way valve. The foam-promoting device is orientated so that the lower orifice is submerged in the beverage in the can, whilst the upper orifice opens into the headspace in the container. Where the one-way valve forms the lower opening means, upon opening of the can, the relatively high pressure differential which thereby arises causes the one-way valve to open and thereby cause discharge of gas into the beverage. However, the disadvantage of such an arrangement is that a certain amount of gas is also discharged from the foam-promoting device through the open upper orifice. This can have a material effect on the desired foaming of the beverage. If the upper orifice is made sufficiently small that the amount of gas discharged therefrom is insignificant, flushing of the foam-promoting device to remove air therefrom can become difficult. Additionally, the provision of a one-way valve

increases the overall cost of the foam-promoting device. In the case of the foam-promoting devices wherein the one-way valve provides the upper opening means, this is said to permit gas to be introduced into the foam-promoting device after filling, sealing and pressurisation. When the container is opened, the resultant pressure differential is said to cause gas to be ejected into the beverage through the open lower restricted orifice. However, with such a design, it is possible for a substantial quantity of beverage to enter the foam-promoting device via the open lower restricted orifice subsequent to filling, sealing and pressurisation of the container. Additionally, the cost of the foam-promoting device is relatively expensive because of the need to provide the one-way valve.

GB-A-2280887 (and WO95/05325) discloses a number of foam-promoting devices having upper and lower one-way valves, the upper one-way valve permitting gas to be introduced from the headspace into the foam-promoting device after filling, sealing and pressurisation whilst the lower one-way valve permits gas from the foam-promoting device to be ejected into the beverage when the container is opened. However, such a foam-promoting device is even more costly to produce than that of GB-A-2280886 described above.

Further foam-promoting devices are disclosed in WO95/03982, WO95/03983 and WO95/04688 which describe various forms of floating/submersible devices designed to capture gas in one orientation and then to re-orientate so as to hold the captured gas and enable it to be ejected into the liquid in the container so as to assist in foam promotion when the beverage container is opened. In WO95/03982, the device floats initially on the surface of the beverage in a sealed, pressurised can. In this condition, gas is captured from the headspace

within the can through a hole in the device which is located in the headspace in the can. The device also includes a wick which draws beverage into the device through a hole which is submerged in the beverage. The act of drawing beverage into the wick alters the centre of gravity and the density of the device so that it re-orientates and least partially sinks so that the gas capture hole becomes submerged. Thus, upon opening of the can, gas under pressure within the device is discharged through the submerged hole and assists in foam-promotion.

In WO95/03983, a floating foam-promoting device is disclosed which is divided internally by a partition dividing the interior of the device into a gas compartment in which gas is trapped and a beverage compartment in which beverage is trapped. Diametrically opposed holes in the wall of the device open into respective tubes which pass through the adjacent compartment and open into the other compartment. The beverage compartment is also provided with one or more further holes providing direct communication between that compartment and the exterior of the device. The device is weighted so that initially gas is captured in the gas compartment because the gas admission hole communicating therewith is exposed in the headspace in the can. The or some of the holes for the beverage compartment are submerged so that beverage enters such compartment and alters the centre of gravity and density of the device so that it becomes at least partly submerged and is re-orientated to such an extent that the gas admission hole becomes submerged. Thus, when the beverage container is opened, gas under pressure from the gas compartment within the device is discharged into the beverage to assist in foam promotion.

WO95/04688 also discloses a number of devices where an internal partition divides the device into gas and beverage compartments connected to the exterior via various tubes in the device. Like the devices of WO95/03983, the devices of WO95/04688 are designed to become at least partially submerged and to re-orientate to enable gas captured in one orientation to promote foam production upon opening of the container when the device is submerged and re-orientated.

However, the devices of WO95/03982, WO95/03983 and WO95/04688 are of relatively complex construction and the desired operations can be impaired in the event that correct re-orientation of the device fails to take place.

It is therefore an object of the present invention to provide a sealed, openable, pressurised liquid container which can possess the installation advantages of a floating foam-promoting device, the ease of flushing of a foam-promoting device having more than one restricted orifice, and the safety of a foam-promoting device which is not of the sealed type, and which is also economical to produce.

According to a first aspect of the present invention, there is provided a sealed, openable, pressurised liquid container comprising a container partly filled with liquid to provide a headspace within the container, and a foam-promoting device disposed within the container, said foam-promoting device comprising a hollow body having first and second passage means, said first passage means having (a) an upper end in communication with the exterior of the hollow body at an upper location which is disposed in the headspace in the container and (b) a lower end in communication with the interior of the hollow body, and said second

passage means having (a) a lower end in communication with the exterior of the hollow body at a lower location which is disposed below the surface of the liquid in the container and (b) an upper end in communication with the interior of the hollow body, wherein the lower end of the first passage means is disposed at a lower level than the upper end of the second passage means, and wherein the foam-promoting device is partly filled with liquid to a level which is above that of the lower end of the first passage means.

Preferably, the level of the liquid in the foam-promoting device is intermediate the levels of the lower end of the first passage means and the upper end of the second passage means so that the lower end of the first passage means is submerged in the liquid in the device and the upper end of the second passage means is disposed above the level of the liquid in the device. However, it is within the scope of the present invention for the level of the liquid in the foam-promoting device to be above (preferably by only a minimal amount) the upper end of the second passage means.

With such an arrangement, there is no need to provide one or more one-way valves. Flushing of the foam-promoting device can be effected relatively easily because of the existence of more than one opening into the foam-promoting device. Thus, standard bottle flushing technology which has been known for many years can be employed after the foam-promoting device has been introduced into the container immediately before filling of the container with liquid. The first passage means, being in communication with the headspace in the container, enables gas under pressure to flow into the foam-promoting device after sealing and pressurisation without the need to invert the container promptly after

sealing, thereby permitting the use of the invention with containers such as bottles where it is undesirable to invert for pasteurisation. After sealing, as the pressure in the container increases, gas from the headspace in the container enters the foam-promoting device via the first passage means, whilst introduction of a much smaller amount of liquid takes place through the second passage means because of its much greater resistance to flow in view of its greater density and viscosity. Similarly, when the container is opened, gas from the foam-promoting device can be readily discharged through the second passage means and into the liquid in the container to promote foaming, if necessary after discharge of any small amount of liquid which may be disposed within the second passage means at that stage. At the same time, the first passage means will discharge any small volume of gas which it contains, and will then discharge liquid because its lower end is immersed in the liquid within the hollow body of the device. Compared to ejection of gas from the second passage means, the discharge of liquid from the first passage means will be greatly restricted because of the density and viscosity effects described above.

According to a second aspect of the present invention, there is provided a foam-promoting device constructed and adapted to form part of a sealed, openable, pressurised liquid container according to said first aspect of the present invention, said foam-promoting device comprising a hollow body having first and second passage means therein, said first passage means having (a) an upper end in communication with the exterior of the hollow body at an upper location and (b) a lower end in communication with the interior of the hollow body, and said second passage means having (a) a lower end in communication with the exterior of the hollow body at a location which is spaced below the

upper end of the first passage means and (b) an upper end in communication with the interior of the hollow body, wherein the lower end of the first passage means is disposed at a lower level than the upper end of the second passage means.

According to a third aspect of the present invention, there is provided a method of manufacturing a liquid container according to said first aspect of the present invention, comprising the steps of:-

(a) partly filling a liquid container with beverage so as to provide a headspace;

(b) before, during or after said filling step (and preferably before), introducing a foam-promoting device according to said second aspect of the present invention into the container;

(c) sealing and pressurising the container with the foam-promoting device therein; and

(d) causing liquid to enter the hollow body of the foam-promoting device so that the level of liquid within the hollow body lies above the lower end of the first passage means and, preferably, below the upper end of the second passage means.

Step (d) above is preferably effected by permitting liquid which has been introduced into the container to flow into the foam-promoting device to the required level as a result of pressurisation of the container in step (c).

Whilst it is preferred for the device to float on the surface of the liquid in the container, it is also within the scope of the present invention for the hollow body of the device to be held or supported within the container at the desired position relative to the level of liquid therein by any convenient means, eg at least one support leg which may extend

downwardly from the hollow body to engage against the base of the container. Such a support leg need not be fixed to the container, but may be fixed to the hollow body and merely rest against the base of the container. The support leg may be resiliently flexible so that it can be deformed to permit the hollow body to be displaced by a filling nozzle during filling of the container with the liquid and can then flex back so that the device (weighted as necessary so that it does not float) can adopt the required position relative to the surface of the liquid in the filled container.

Most preferably, the first and second passage means open into a common chamber within the hollow body. Thus, there is no need to divide the body into compartments with the result that the gas-storing volume of the device can be maximised.

It is particularly preferred for each of the first and second passage means to have a restricted orifice associated therewith through which the interior of the foam-promoting device communicates with the exterior. More preferably, the restricted orifice associated with the second passage means is provided in an external wall of the hollow body. The restricted orifice associated with the first passage means may be provided in the external wall of the hollow body or it may be provided at a location which is below the level of the liquid within the hollow body in use. The restricted orifice associated with the first passage means may have a cross-sectional area which is larger than, smaller than or equal to that of the restricted orifice associated with the second passage means and/or it may be provided in a wall whose outer surface is formed of a hydrophobic material. The longitudinal axis of each restricted orifice may be aligned with or inclined with respect to the direction of extent of the respective passage means.

A further restricted orifice may be provided in a region of the hollow body which is to be submerged in the liquids internally and externally of the body so as to provide direct communication between such liquids in use.

Each of the first and second passage means may be defined by a respective tube which may be integrally formed with the hollow body. Alternatively, one or both of the passage means may be formed in one or more walls of the hollow body. The hollow body together with the first and second passage means may be formed from a synthetic plastics material such as polypropylene and may be formed in two parts which are secured together by any desired technique eg by ultrasonic welding, hot plate welding or snap-fitting.

In this description, the expressions "upper", "lower", "above" and "below" refer to the arrangement of the respective parts when the foam-promoting device is in an orientation in which it is designed to float or be otherwise supported in use. In the case where the device is designed to float, depending upon the design and the material of construction of the foam-promoting device, it may be provided with positive or negative buoyancy means or other orientation means such as to ensure that it floats in the desired orientation with the upper end of the first passage means spaced above the level of liquid in the container and the lower end of the second passage means submerged below such liquid level. The negative buoyancy means may comprise one or more weights, e.g. glass balls, fixed in the device and/or it may comprise external negative buoyancy means attached below the body. An example of another orientation means is a leg which extends downwardly from the body of the device to abut against the interior surface of the container in use in

such a way as to constrain the device to float in the required orientation.

The hollow body of the foam-promoting device may be manufactured so as to be resiliently collapsible or deformable so that it can be introduced into the container if its natural dimensions are too great to enable it to be freely inserted. Alternatively, the hollow body may be formed with one or more resiliently deformable external projections thereon which require to be deformed to enable the device to be introduced into the container and which can then spring back to prevent the device from coming back out of the container when liquid is dispensed therefrom. Such projection(s) is/ are most preferably relatively localised. The provision of one or more localised projections can also serve to prevent the hollow body from becoming lodged in, and thereby obscuring, the neck of the bottle. This prevents undue restriction in flow through the neck of the bottle and thus (a) enables easy pouring of liquid from the bottle, and (b) permits relatively free flow of air or water into the bottle during washing of the latter in an inverted condition to remove foreign objects immediately prior to filling with the liquid.

The provision of localised projection(s) is particularly applicable in the case of foam-promoting devices which are to be introduced through the relatively narrow neck of a bottle. In the case of bottles which are required to be fitted with a standard crown closure or screw cap, the lower end of the neck of the bottle may be somewhat enlarged in order to permit the foam-promoting device to float freely in the neck since it is normal practice for the bottles to be filled with liquid up to the neck thereof.

It is a disadvantage of existing foam-promoting devices that excessive foaming can take place upon opening of containers in which the liquid has a relatively high carbon dioxide content, eg when the carbon dioxide content is more than 1.2 vols/vol of liquid, more particularly above 1.5 vols/vol.

It is therefore an object of a fourth aspect of the present invention to obviate or mitigate this disadvantage.

According to said fourth aspect of the present invention, there is provided a sealed, openable, pressurised liquid container comprising a container partly filled with liquid to provide a headspace within the container, and a foam-promoting device disposed within the container and floating on the surface of the liquid, said foam-promoting device comprising a hollow body containing pressurised gas and an outlet orifice which provides communication between the interior of the hollow body and the exterior, wherein the outlet orifice is defined by a nozzle which is spaced below the surface of the liquid and directed generally or substantially parallel to the surface of the liquid.

It is found that the use of such a nozzle enables the foam-promoting device to be used without excessive frothing in liquids having higher carbon dioxide contents than has heretofore been thought possible.

Preferably, the nozzle converges towards the outlet orifice.

According to a fifth aspect of the present invention, there is provided a sealed, openable, pressurised liquid container comprising a container partly filled with liquid to provide a headspace within the container, and

a foam-promoting device disposed within the container, said foam-promoting device comprising a hollow body which contains gas and which is adapted to discharge said gas into the liquid in the container when the latter is opened, wherein the hollow body is elongate and is adapted to float in the liquid with its long axis upright.

The present invention will now be described, in further detail, with reference to the accompanying drawings, in which:-

Fig 1 is a schematic axial section through a first embodiment of foam-promoting device according to said second aspect of the present invention, the foam-promoting device being shown in a condition in which it exists when located in a sealed, openable, pressurised beverage container and is in a state of equilibrium after pressurisation of such container and before opening thereof,

Fig 2 is a view similar to Fig 1 showing the device in a condition which exists immediately upon opening of the beverage container,

Fig 3 is a view similar to Fig 1 showing the device in a condition in which it exists during initial pressurisation of the beverage container following sealing,

Fig 4 is a schematic view of a sealed, openable, pressurised beverage container in the form of a bottle containing a foam-promoting device according to the present invention,

Fig. 5 is a view similar to Figs 1 of a second embodiment of foam-promoting device according to said second aspect of the present invention,

Fig. 6 is a plan view of a right-hand dished body part which, together with a left-hand dished body part illustrated in Figs 8 and 9, forms a third embodiment of foam-promoting device according to said second and fourth aspects of the present invention,

Fig. 7 is a side elevation (with part shown in section) of the body part of Fig. 6,

Fig. 8 is a plan view of the left-hand dished body part of the third embodiment of foam-promoting device according to said second and fourth aspects of the present invention,

Fig. 9 is a cross-section of the left-hand body part illustrated in Fig. 8,

Fig. 10 is an axial section through a further embodiment of foam-promoting device according to the second and fourth aspects of the present invention,

Fig. 11 is an axial section through a still further embodiment of foam-promoting device according to the second and fourth aspects of the present invention,

Fig. 12 is an axial section through another embodiment of foam-promoting device according to the second and fourth aspects of the present invention, and

Fig. 13 is a schematic view of a further embodiment of foam-promoting device according to the second and fourth aspect of the present invention shown disposed in a bottle.

Referring now to Fig 1, the foam-promoting device D comprises a hollow body 10 having a cylindrical side wall 10a of circular cross-section and convexly curved end walls 10b. The hollow body 10 is formed of injection moulded polypropylene with first passage means defined by a first tube 12 and second passage means defined by a second tube 14. The tubes 12 and 14 are integrally formed with the hollow body 10 which may be produced in two identical halves which are secured together by any desired means such as by ultrasonic welding along a joint line which lies in the plane of the drawing. Alternatively, the hollow body may be of non-circular cross-section, eg ovoidal cross-

section with the tubes 12 and 14 extending transversely with respect to the shorter axis of the ovoid.

The first tube 12 has an upper end 12a which communicates with the exterior of the hollow body 10 via an upper restricted orifice 16 formed during the moulding of the halves or by any other technique, eg laser drilling, through the side wall 10a so that the axis of the orifice is inclined to the longitudinal axis of the first tube 12. The first tube 12 extends downwardly within the hollow body 10 to terminate at a lower end 12b which is disposed a short distance from the diametrically opposite side of the side wall 10a and which opens into the interior of the hollow body 10.

The second tube 14 has a lower end 14a which communicates with the exterior of the hollow body 10 via a lower restricted orifice 18 formed in the side wall 10a of the body 10 diametrically opposite the upper restricted orifice 16 but displaced therefrom in the axial direction of the side wall 10a. The second tube 14 extends upwardly within the hollow body 10 to terminate in an upper end 14b which is disposed a short distance from the diametrically opposite side of the side wall 10a and which opens into the interior of the hollow body 10. It will thus be appreciated that the lower end 12b of the first tube 12 is disposed at a lower level than the upper end 14b of the second tube 14.

In Fig 1, the foam-promoting device D is shown floating on its side on the surface of beverage 20 which partly fills a sealed, openable, pressurised beverage container (not shown in Fig 1) so that a headspace 22 is provided within the container. Although not illustrated in Fig. 1, the side wall 10a has a greater wall thickness at its lower side than at its

upper side (as viewed in Fig. 1) so that it is weighted to adopt the position illustrated in Fig. 1 where the lower end 14a of the second tube 14 is lowermost and the upper end 12 of the first tube 12 is uppermost. Alternatively, appropriate positive or negative buoyancy aids may be provided in or on the foam-promoting device to ensure that it adopts the orientation illustrated in Fig 1. As a further alternative, the cross-sectional shape of the hollow body 10 may be chosen to ensure that it has a mono-stable floating orientation.

The hollow body 10 also contains a small quantity of beverage 24 which is derived from the beverage 20 as a result of the procedure used to produce the sealed container, as will be described hereinafter. Thus, as can be seen from Fig 1, the foam-promoting device floats in a partly submerged condition on the surface of the beverage 20 so that the lower orifice 18 is submerged in the beverage 20, whilst the upper restricted orifice 16 is disposed within the headspace 22 of the beverage container. The level of beverage 24 within the hollow body 10 is such that it covers the lower end 12b of the first tube 12 but is well below the upper end 14b of the second tube 14.

Under steady state conditions in the sealed container, the liquid levels within the tubes 12 and 14 are as illustrated in Fig. 1. The device floats with the level of beverage 24 within the hollow body 10 below that of the beverage 20 outside the hollow body 10 because of the effect of the weight of that part of the body 10 which is above the surface of the beverage 20 and because polypropylene is a material of approximately neutral buoyancy. The beverage levels in the tubes 12 and 14 are as shown in Fig. 1 where the difference in levels between the beverage 20 outside the body 10 and the beverage 20 within the second tube 14 is

the same as the difference in levels between the majority of the beverage 24 within the body 10 and the beverage 24 within the first tube 12.

Whilst the sealed pressurised beverage container is being transported and/or stored prior to use, it will inevitably be subjected to a range of temperature variations which can cause small pressure differentials to be established between the interior and exterior of the foam-promoting device D. In such a case, when the exterior pressure exceeds the interior pressure, pressure equalisation can take place either by admission of gas from the headspace 22 into the foam-promoting device D via the upper restricted orifice 16 and first tube 12 by bubbling through the beverage 24 covering the lower end 12b, or by admission of beverage 20 which passes through the lower restricted orifice 18 and up the second tube 14, or by a combination of these two actions. In the case where the interior pressure exceeds the exterior pressure, the reverse takes place. In any event, the pressure differentials which occur during normal handling and storage of the sealed container are generally relatively small and occur over a relatively long period of time.

Referring now to Fig 2, when the pressurised beverage container is opened, the pressure externally of the hollow body 10 in the headspace 22 and in the beverage 20 suddenly decreases. The effect of this is to cause the still-pressurised gas within the headspace 26 of the hollow body 10 to be ejected via the lower orifice 18 into the beverage 20 so as to promote foam formation in the latter, after any residual beverage 20 in the second tube 14 has been forced through the restricted orifice 18. The beverage forced out of the lower restricted orifice 18 from the tube 14 does not assist in foam formation within the beverage 20 but may be advantageous in providing a short delay before gas from the hollow body

10 is ejected through the lower restricted orifice 18. Such delay may be advantageous to ensure that the pressure within the opened beverage container has dropped to atmospheric pressure before gas starts to be ejected through the lower restricted orifice 18. During this time, it will be appreciated that beverage 24 from the hollow body 10 is being forced through the lower end of the first tube 12 and up the latter. Thus, the beverage 24 displaces the gas which is in the first tube 12 through the upper restricted orifice 16 and into the headspace 22. Whilst this does not promote foam formation in the beverage 20, the amount of gas ejected through the upper restricted orifice 16 is relatively small before beverage 24 has passed completely along the first tube 12 and starts to be urged through the upper restricted orifice 16. The resistance to flow of the beverage through the upper restricted orifice 16 is much more than the resistance to flow of gas through the lower restricted orifice 18, with the result that gas is preferentially ejected into the beverage 20. It will be appreciated that ejection of gas from the lower restricted orifice 18 does not occur directly downwardly and that ejection of beverage 24 from the upper restricted orifice does not occur directly upwardly because of the direction of extent of the orifices 16 and 18.

Referring now to Fig 3, the foam-promoting device D is shown in a condition which exists shortly after there has been a rapid increase in pressure within the beverage container immediately following sealing thereof. Typically, such rapid increase in pressure occurs as a result of introduction of a small dose of liquid nitrogen into the beverage container immediately before sealing, at which stage the device D contains no beverage 24 derived from the beverage 20. When this rapid increase in pressure occurs, gas from the headspace 22 enters the upper restricted orifice 16 much faster than beverage can enter via the lower

restricted orifice 18 because of the density and viscosity difference between the gas and the beverage. Thus, the hollow body 10 is effectively charged with gas under pressure via the upper restricted orifice 16 from the headspace 22 and is also charged with a smaller quantity of beverage via the lower restricted orifice 18.

It is to be understood that the sizes of the orifices 16 and 18 and the sizes of the other parts of the device D can be appropriately selected having regard to the dosing gas pressure and type and the flow properties of beverage 20 to ensure that the correct amount of beverage enters the device D after sealing and pressurisation has been completed.

Referring now to Fig 4, there is shown a schematic representation of a sealed, openable, pressurised beverage container in the form of a bottle B which has been partly filled with the beverage 20 so as to provide the headspace 22 and which contains the foam-promoting device D. The bottle B includes a neck N which is moulded to include an enlarged neck region E which accommodates the foam-promoting device D so that it can float on the surface of the beverage 20. The neck N is closed by a conventional, openable crown cap C. When the cap C is opened by the consumer, gas is ejected from the foam-promoting device into the beverage 20 as described hereinabove in relation to Fig 2.

In the manufacture of the sealed and filled bottle B, it is always maintained in an upright condition, i.e. with its neck N upright. Initially, the foam-promoting device is introduced into the bottle B through the open end of the neck N, i.e. before fitting of the cap C. The bottle B including the interior of the device D is purged of air in the usual way for bottled beverages by applying a standard purging head to the open

neck of the bottle B to purge the latter and the device D with inert gas, eg carbon dioxide or nitrogen. Then the bottle B containing the purged foam-promoting device D is passed to a location at which the beverage 20 is introduced through the open neck N to fill the bottle B to the desired level whereby the headspace 22 is provided. As the bottle B is filled, the foam-promoting device D continues to float on the beverage 20. Then, a small quantity of liquid nitrogen is introduced into the neck N following immediately by closure of the bottle B by crimping of the cap C to the neck N. After closure, the pressure within the bottle B rapidly rises to cause the device D to be charged with gas and to be filled with the beverage 24 to the required level as described hereinabove in relation to Fig 3.

Whilst the bottle B is still in its upright condition, it is transported to a pasteuriser where it is subjected to an elevated temperature followed by cooling still in the upright condition. Throughout this procedure, the foam-promoting device D remains an orientation corresponding to that illustrated in Figs 1 to 3 with the upper restricted orifice 16 remaining in the headspace 22 and the lower restricted orifice 18 remaining submerged in the beverage 20.

Referring now to Fig 5, the device D illustrated therein is similar to that of Figs 1 to 3 and similar parts are accorded the same reference numerals. In this embodiment, however, the lowermost wall region of the hollow body 10 has an additional restricted orifice 30 therethrough providing direct communication between the interior and the exterior of the hollow body 10. The restricted orifice 30 is submerged in the beverage 20 outside the device D and is covered by the beverage 24 within the device D. The restricted orifice 30 is provided so as to reduce

the risk of loss of gas from the inside of the hollow body 10 in the event that the sealed beverage container is subjected to many temperature fluctuations during storage and/or transportation. In the device D of Figs 1 to 3, if the sealed container cools down, gas may be lost to an undesirable extent from the interior of the hollow body 10 through the lower restricted orifice 18 if there is a film of beverage over the upper restricted orifice 16. Under such circumstances, first liquid and then some gas may be drawn through the lower restricted orifice 18 to be replaced only by liquid when the sealed container warms up. The presence of a film of beverage over the orifice 16 prevents gas from entering the device D via the orifice 16 when the sealed container warms up. In contrast, in the device D of Fig 5, under such temperature fluctuations, beverage can flow in to and out of the hollow body 10 via the restricted orifice 30 without gas being drawn through the restricted orifice 30 or the restricted orifice 18 during a cooling cycle.

Referring now to Figs. 6 to 9, the third embodiment of foam-promoting device D is similar to that of Fig 5 and parts serving the same functions are accorded the same reference numerals. In this embodiment, the device D is formed of a right-hand dished body part D_1 (Figs 6 and 7) and a left-hand dished body part D_2 (Figs 8 and 9) moulded with respective planar rims 40 and 42 which are secured together in mutually sealing relationship to define the hollow body 10. The right-hand body part D_1 is moulded with recesses 12 and 14 at opposite ends thereof corresponding to the end walls 10b of the body 10, the first and second recesses 12 and 14 defining the first and second passage means of the device D and corresponding, in the complete device D, to the tubes 12 and 14. The upper, lower and the additional restricted orifices 16, 18 and 30 are provided in the right-hand body part D_1, with the lower

restricted orifice 18 opening into the lower end of the second recess 14 and the additional restricted orifice 30 opening into the lower end of the first recess 12. Thus, all of the orifices 16, 18 and 30 are directed parallel to the surface of the beverage in use. Additionally, each orifice 16, 18 and 30 is defined by a respective nozzle having a passage which tapers inwardly towards the orifice and which is formed in the wall of the body part D_1.

As can be seen from Figs 6, 8 and 9, the wall thicknesses of the body parts D_1 and D_2 in those regions corresponding to the lower or submerged part of the device D are greater than the wall thicknesses corresponding to the upper part of the device D. Such greater wall thicknesses result in added weight which causes the device D to adopt the desired orientation when floating. The body parts D_1 and D_2 have integrally moulded, sloping-sided protrusions 41 and 43. Such protrusions 41 and 43 are provided so that the relevant dimension of the device D exceeds the diameter of the neck N of the bottle B by a small amount. The act of inserting the device D into the neck N causes the protrusions 41 and 43 to be resiliently deformed inwardly by the neck N. After insertion, the protrusions 41 and 43 spring back to oppose removal of the device D from the bottle B and to prevent the device D from blocking passage of beverage while it is being poured from the bottle B.

In Fig 6, the typical dimensions of the device are indicated in mm and each of the upper, lower and additional restricted orifices 16, 18 and 30 has a diameter of 0.25 mm.

Referring now to Fig. 10, the device illustrated therein has elongated hollow body 10 which is adapted to float with its long axis upright. In

this embodiment, the second tube 14 extends through the bottom of the hollow body 10 and the lower end 14a of the tube 14 is furnished with a nozzle 40 which defines the lower restricted orifice 18 and with a weight 42. The weight 42 is arranged to cause the device to float so that, when the body 10 contains the desired amount of liquid 24, the nozzle 40 is disposed about 15 mm below the surface of the beverage 20 and is directed longitudinally of the direction of extent of the surface. In this embodiment, the nozzle 40 is directed parallel to the surface of the beverage 20. Upon opening of the container in use, ejection of gas takes place laterally a short distance below the surface of the beverage 20 so that the bubbles generated by such ejection stay close to the surface of the beverage 20 and do not cause uncontrolled foaming of the main body of the beverage 20. Thus, when a carbonated beverage 20 is used, the nucleation of bubbles of carbon dioxide from the main body of the beverage 20 is minimised, thereby allowing the device to be used with beverages having a relatively high carbon dioxide content without causing overflow of froth or beverage from the bottle neck.

Also, in the embodiment of Fig. 10, the additional restricted orifice 30 is defined by an additional nozzle 44 provided in the wall of the hollow body 10 so as to be directed downwardly and outwardly. Nozzle 44 allows beverage to flow into and out of the body 10, preventing unwanted loss of gas as described above in relation to the restricted orifice 30 of Fig. 5.

Referring now to Fig. 11, there is shown a device which is intended to float with its long axis upright, like the embodiment of Fig. 10. In this case, however, weight 42 is provided by a glass ball which is held in the hollow body 10 by any convenient means, e.g. by being trapped in

place by appropriate design of moulded body parts forming the body 10. Upper and lower resiliently deformable legs 48 and 50 project obliquely laterally outwardly from the upper and lower end faces of the hollow body 10 beyond the external side wall of the latter. The diameter of the body 10 is such that it can be inserted through the neck of a bottle. In order to insert the body 10, the legs 48 and 50 are deformed appropriately towards the upright long axis of the body 10. Once the device is in the bottle, the legs 48 and 50 are free to spring back to the positions illustrated in Fig. 11 to prevent unwanted passage of the device back out of the bottle, and also to prevent undue restriction to free flow of (a) beverage through the neck upon pouring, and (b) air or water during cleaning/washing of the bottle in an inverted condition to remove foreign bodies immediately prior to filling with the beverage.

The length of the second tube 14 is chosen, in this embodiment, such that its upper end is submerged in use to a small extent in the beverage 24 within the hollow body 10. This enables the second tube 14 and orifice 18 to serve a similar function to that of the previously described orifice 30 in that it assists in preventing loss of gas from the body 10 in the event of the sealed beverage container being subjected to many temperature fluctuations during storage or transportation. Furthermore, it will be understood that the reduction in pressure which occurs upon opening of the bottle causes beverage to be ejected from the body 10 initially through the tube 14 and orifice 18. Because of the density and viscosity of such beverage, this takes a certain length of time and so the pressure within the hollow body 10 drops at a much slower rate than the pressure drop within the bottle By the time gas starts to be discharged, the pressure within the bottle externally of the body 10 has dropped

considerably, thereby enhancing the foam-producing effect of the gas discharge through the orifice 18.

The axial length of the body 10 may be chosen as desired to enable the required gas capacity of the device to be achieved. The device may be shorter than that illustrated in Fig. 11, or it may be longer as illustrated in Fig. 12.

In Fig. 12, two glass balls 42 are provided to achieve the necessary weighting effect to ensure that the device floats with its long axis in an upright condition. Additionally, in Fig. 12, tube 12 also extends upwardly from the body 10 through an upwardly extending spigot 51. This assists in ensuring that the upper restricted orifice 16, being located at the upper end of the spigot 51, remains free of any liquid or foam in the headspace. In this embodiment, however, unlike that of Fig. 11, the second tube 14 is disposed above the surface of the beverage (not shown) within the body 10, and orifice 30 is provided for the purpose previously mentioned.

Referring now to Fig. 13, a device similar to that described above in relation to Fig. 11 is employed. However, in this embodiment, leg 50 is extended and thereby serves as an orientation means to constrain the device so that it floats in the desired upright orientation. This design enables the ball or balls 42 to be dispensed with, thereby increasing the available volume for gas within the hollow body 10.

Although, the device of Fig. 13 is arranged to float, in a modification, such device is not of the floating type but is weighted as necessary so that it does not float and is arranged to be supported at the required level

within the bottle B by means of the extended support leg 50 which abuts against the base 54 of the bottle B. In this case, the support leg 50 is resiliently flexible so that it can be deformed to permit the hollow body 10 to be displaced by a filling nozzle (not shown) introduced into the neck of the bottle B during filling of the latter with the liquid. After filling, the leg 50 can flex back so that the device can adopt the required position relative to the surface of the liquid in the filled container.

In a further modification, the device of Fig. 13 is provided with an orifice 30 serving the previously described function.

CLAIMS

1. A sealed, openable, pressurised liquid container comprising a container partly filled with liquid to provide a headspace within the container, and a foam-promoting device disposed within the container, said foam-promoting device comprising a hollow body having first and second passage means, said first passage means having (a) an upper end in communication with the exterior of the hollow body at an upper location which is disposed in the headspace in the container and (b) a lower end in communication with the interior of the hollow body, and said second passage means having (a) a lower end in communication with the exterior of the hollow body at a lower location which is disposed below the surface of the liquid in the container and (b) an upper end in communication with the interior of the hollow body, wherein the lower end of the first passage means is disposed at a lower level than the upper end of the second passage means, and wherein the foam-promoting device is partly filled with liquid to a level above that of the lower end of the first passage means.

2. A container as claimed in claim 1, wherein the foam-promoting device is partly filled with liquid to a level which is intermediate the levels of the lower end of the first passage means and the upper end of the second passage means so that the lower end of the first passage means is submerged in the liquid in the device and the upper end of the second passage means is disposed above the level of the liquid in the device.

3. A container as claimed in claim 1 or 2, wherein the first and second passage means open into a common chamber defined within the hollow body.

4. A container as claimed in claim 1, 2 or 3, wherein the device floats on the surface of the liquid in the container.

5. A container as claimed in any preceding claim, wherein each of the first and second passage means has a restricted orifice associated therewith through which the interior of the foam-promoting device communicates with the exterior.

6. A container as claimed in claim 5, wherein the restricted orifice associated with the second passage means is provided in an external wall of the hollow body.

7. A container as claimed in claim 5 or 6, wherein the restricted orifice associated with the first passage means is provided in an external wall of the hollow body.

8. A container as claimed in claim 5 or 6, wherein the restricted orifice associated with the first passage means is provided at a location which is below the level of the liquid within the hollow body in use.

9. A container as claimed in any preceding claim, wherein a further restricted orifice is provided in a region of the hollow body which is to be submerged in the liquids internally and externally of the body so as to provide direct communication between such liquids in use.

10. A container as claimed in any preceding claim, wherein at least one of the first and second passage means is defined by a tube or a respective tube which integrally formed with the hollow body.

11. A container as claimed in any one of claims 1 to 9, wherein at least one of the passage means is formed in a wall or a respective wall of the hollow body.

12. A container as claimed in any preceding claim, wherein the hollow body is formed with one or more resiliently deformable external projections thereon which require to be resiliently deformed to enable the device to be introduced into the container and which can then spring back to prevent the device from coming back out of the container when liquid is dispensed therefrom.

13. A container as claimed in claim 1, substantially as hereinbefore described with reference to Figs. 1 to 4, or Fig. 5, or Figs. 6 to 9, or Fig. 10, or Fig. 11, or Fig 12, or Fig. 13, of the accompanying drawings

14. A foam-promoting device constructed and adapted to form part of a sealed, openable, pressurised liquid container as claimed in any preceding claim, said foam-promoting device comprising a hollow body having first and second passage means therein, said first passage means having (a) an upper end in communication with the exterior of the hollow body at an upper location and (b) a lower end in communication with the interior of the hollow body, and said second passage means having (a) a lower end in communication with the exterior of the hollow body at a location which is spaced below the upper end of the first passage means and (b) an upper end in communication with the interior

of the hollow body, wherein the lower end of the first passage means is disposed at a lower level than the upper end of the second passage means.

15. A method of manufacturing a liquid container as claimed in any one of claims 1 to 13, said method comprising the steps of:-
(a) partly filling a liquid container with beverage so as to provide a headspace;
(b) before, during or after said filling step, introducing a foam-promoting device as claimed in claim 14 into the container;
(c) sealing and pressurising the container with the foam-promoting device therein; and
(d) causing liquid to enter the hollow body of the foam-promoting device so that the level of liquid within the hollow body lies above the lower end of the first passage means.

16. A method as claimed in claim 15, wherein step (d) above is effected by permitting liquid which has been introduced into the container to flow into the foam-promoting device to the required level as a result of pressurisation of the container in step (c).

17. A sealed, openable, pressurised liquid container comprising a container partly filled with liquid to provide a headspace within the container, and a foam-promoting device disposed within the container and floating on the surface of the liquid, said foam-promoting device comprising a hollow body containing pressurised gas and an outlet orifice which provides communication between the interior of the hollow body and the exterior, wherein the outlet orifice is defined by a nozzle

which is spaced below the surface of the liquid and directed generally or substantially parallel to the surface of the liquid.

18. A container as claimed in claim 17, wherein the nozzle converges towards the outlet orifice.

19. A sealed, openable, pressurised liquid container comprising a container partly filled with liquid to provide a headspace within the container, and a foam-promoting device disposed within the container, said foam-promoting device comprising a hollow body which contains gas and which is adapted to discharge said gas into the liquid in the container when the latter is opened, wherein the hollow body is elongate and is adapted to float in the liquid with its long axis upright.

20. A container as claimed in any one of claims 1 to 11, 17, 18 and 19, having a neck with an enlarged lower neck region.

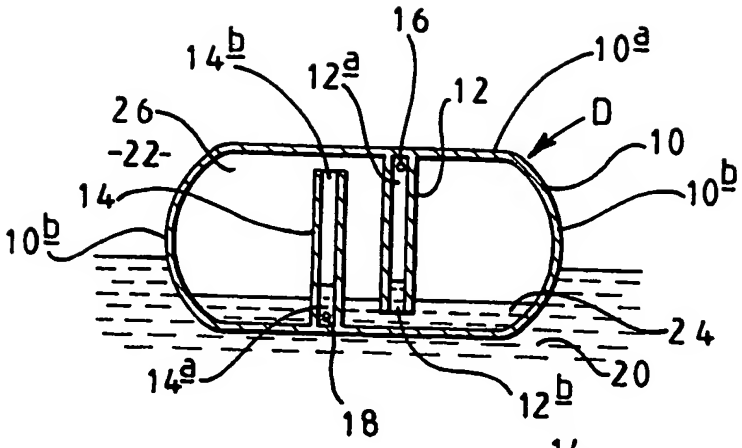

FIG 1

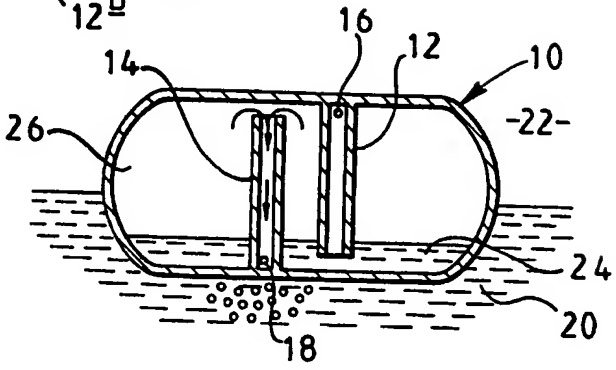

FIG 2

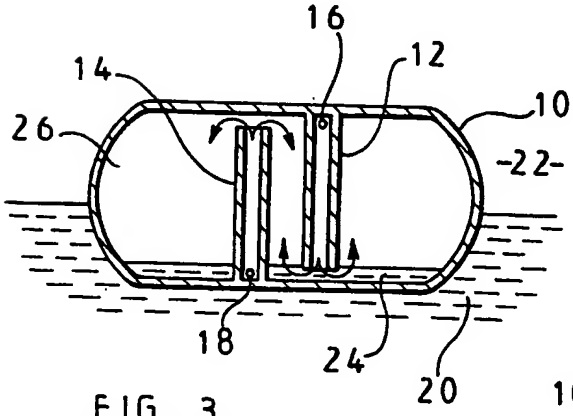

FIG 3

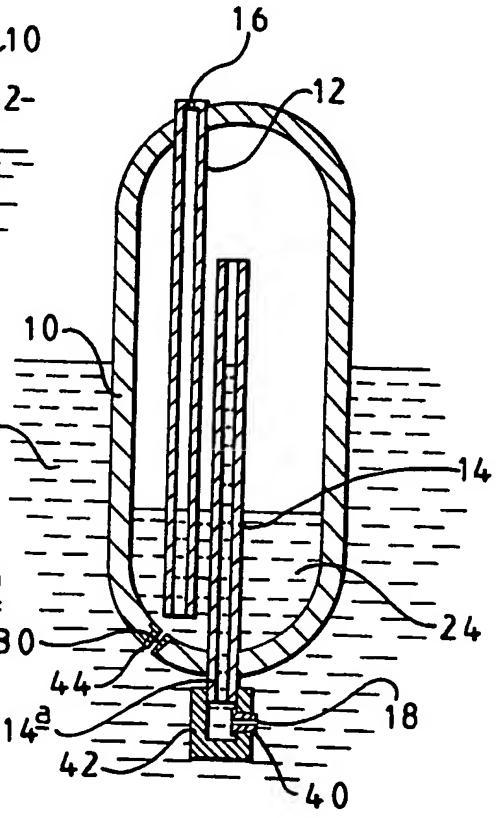

FIG 10

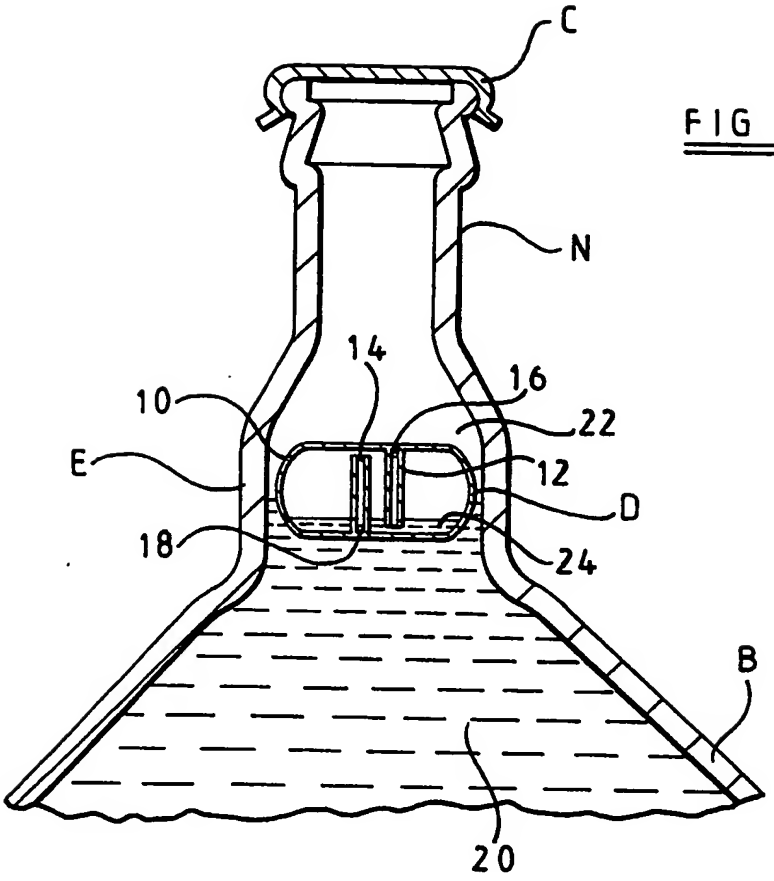

FIG 4

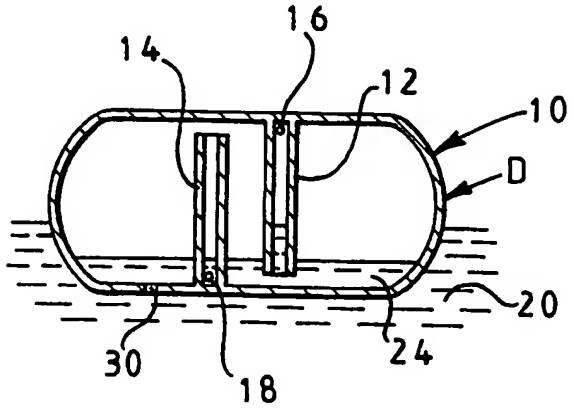

FIG 5

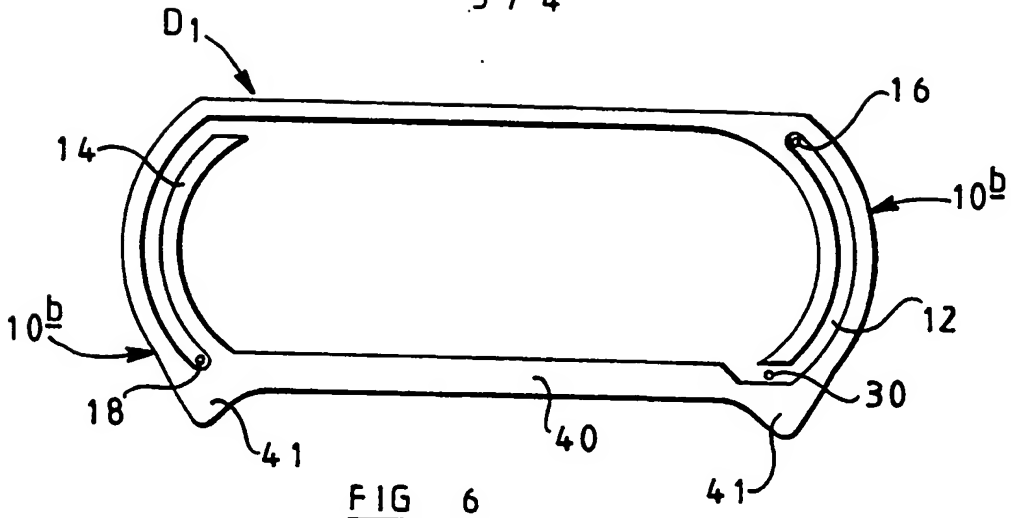

FIG 6

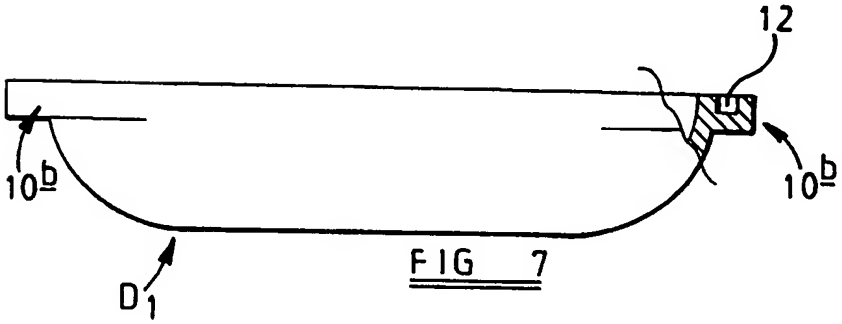

FIG 7

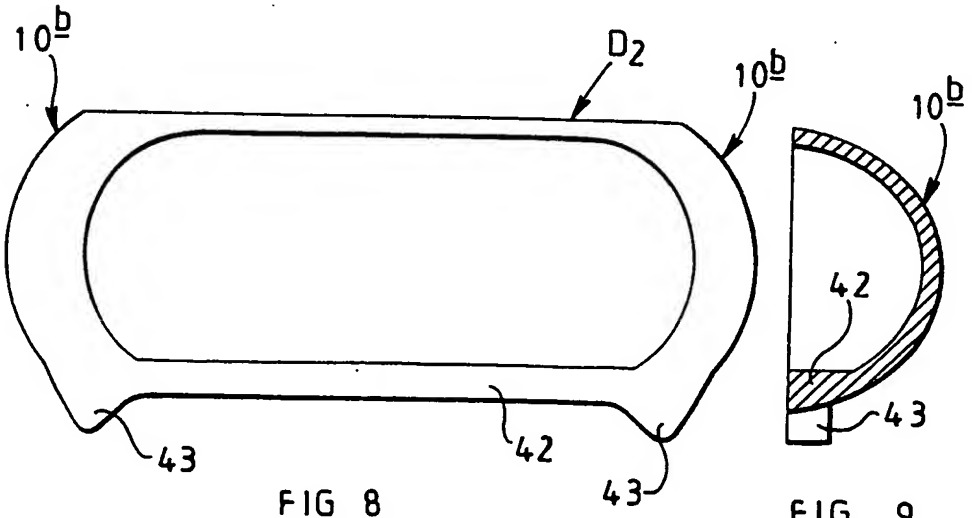

FIG 8

FIG 9

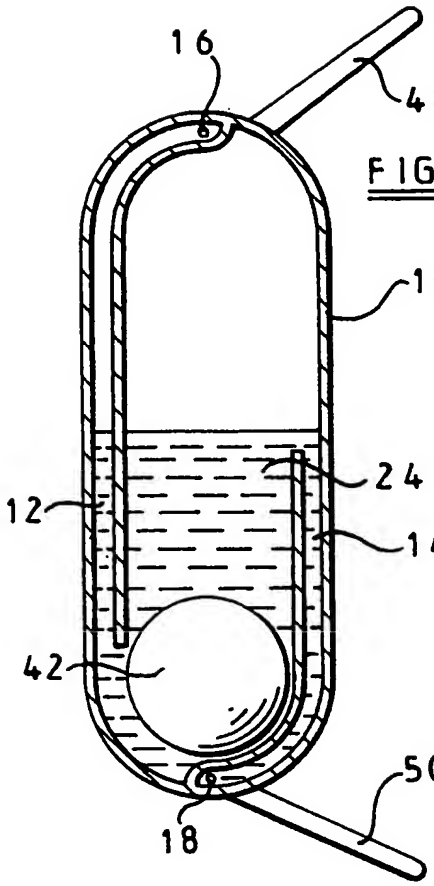

FIG 11

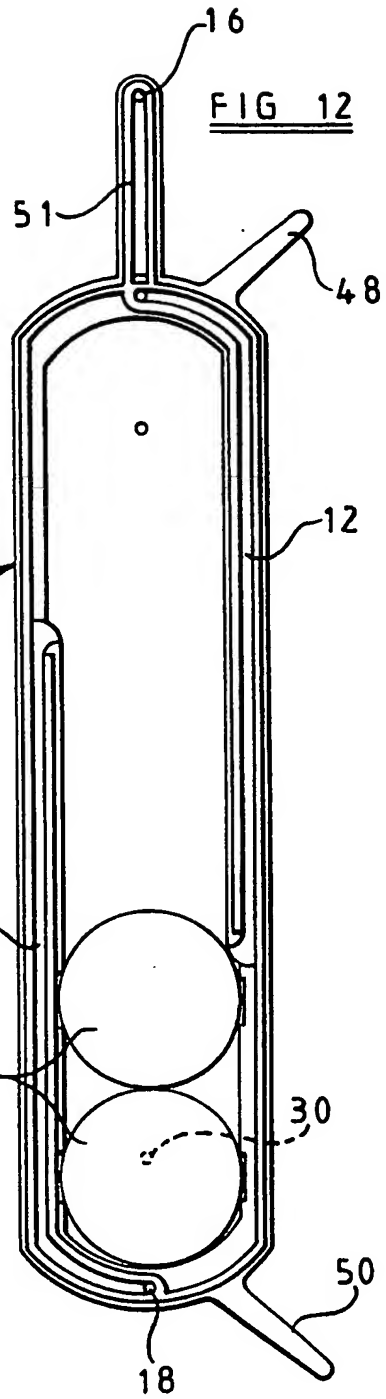

FIG 12

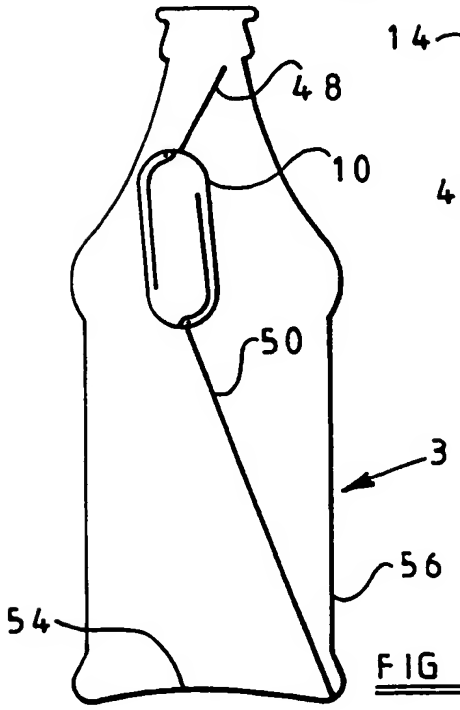

FIG 13